

THE DISTRIBUTION OF EUCALYPTUS SPECIES IN PORTION OF COUNTY STANLEY, SOUTH AUSTRALIA

by MARY A. TODD*

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SUMMARY

This paper reports the distribution of *Eucalyptus* species over an area of about 300 square miles in part of County Stanley, South Australia, centred on the township of Clare, together with such information as to climate and soils as is available.

Eucalyptus leucoxylon var. *pauperita*, *E. camaldulensis*, *E. odorata*, *E. macrorrhyncha*, *E. cladophora*, and the mallee species *E. oleosa*, *E. oleosa* var. *glauca* (= *E. transectinervis*), *E. calcicultrix*, *E. lansdowneana*, and the mallee form of *E. odorata* occur. Tussock grassland, now greatly modified, is also present.

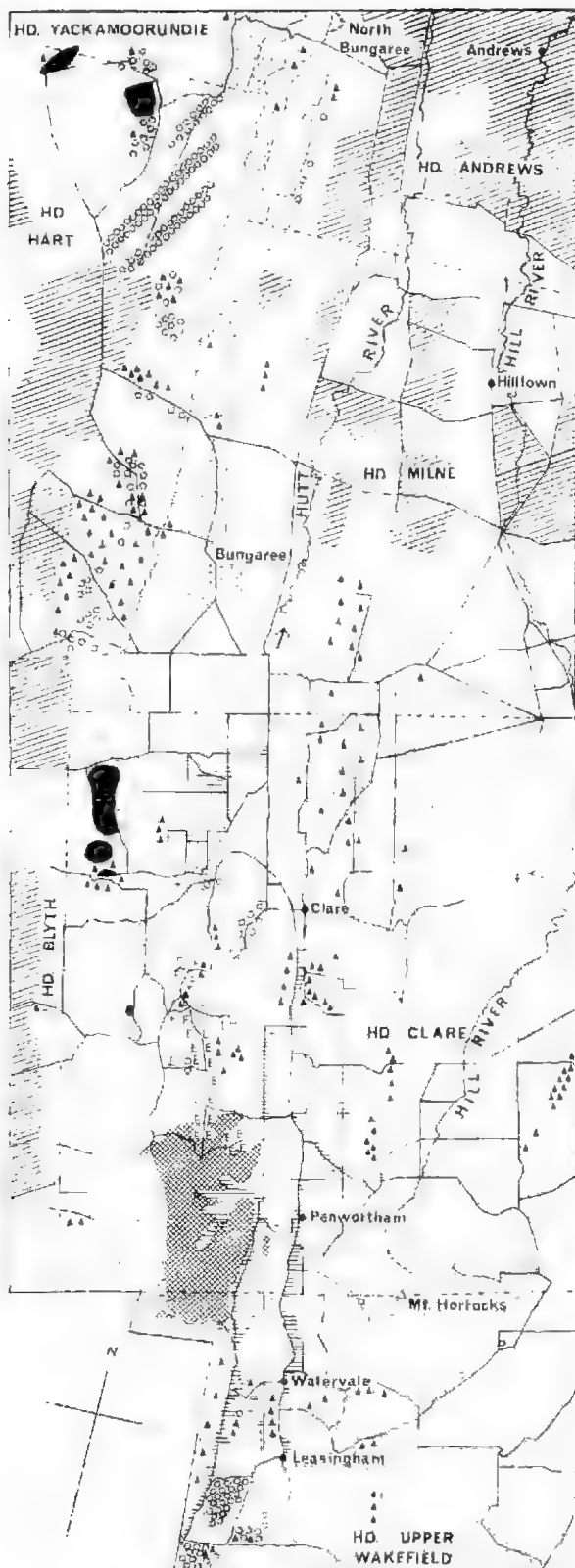
The distribution of *Eucalyptus* species is here recorded over an area of 300 square miles in part of County Stanley, South Australia, including portion of the Hundreds of Upper Wakefield, Clare, Milne, Andrews, Yackamoorundie, Hart and Blyth. Boomsma (1948) had previously noted this for the western section of the Hd. Clare but much of his area was re-examined and some additional information obtained. Most of the detail recorded was obtained during field observations in 1948-50.

Technique. Most of the available roads and some tracks were traversed and the limits of each species of tree were marked on the appropriate hundred maps. Further information about tree distribution was obtained from aerial photographs. Trees had been removed from much of the area but from the remnants still present some idea of the original distribution could be gained.** However, especially in the north and west, old survey records, at the Lands Department, Adelaide, show that natural grasslands occurred and today it is difficult to distinguish these modified grasslands from cleared areas. Soil profiles were examined at representative sites to enable their classification in great soil groups.

Topography. The area includes the most southerly part of the Flinders Ranges. Two main ridges run north and south along the eastern and western boundaries of Hds. Clare, Milne, and Andrews and there are smaller, less continuous ridges between them. Most of the country is undulating, becoming hilly in the southern and western parts of Hd. Clare, the northern part of Hd. Hart, and the adjacent part of Hd. Yackamoorundie. It is mainly drained by the Hutt and Hill Rivers running northwards through Hds. Clare, Milne, and Andrews, while in the west numerous small streams run westwards from the ridge on the western side of Hds. Clare, Milne, and Andrews, and in the south are tributaries of the river Wakefield. Most of the streams are small and tend to dry up in summer.

* c/- Botany Dept., University of Melbourne, Parkville, N.Z., Victoria. Formerly (1948-50) research worker, Agronomy Dept., Waite Agricultural Research Institute, Adelaide.

** In the south, round Watervale and Mintaro, there has been much clearing and also much planting of trees, particularly *Eucalyptus camaldulensis*, so that the existing vegetation does not always indicate the original vegetation. Such evidence as there is suggests that the bulk of that area was originally covered with *E. leucoxylon* var. *pauperita* with *E. odorata* associated in the drier parts.



SCALE IN MILES 0 1 2

ROADS TRAVELLED OVER

TRACKS TAKEN APPROXIMATE POSITION

HUNDRED BOUNDARIES

EUCALYPTUS LEUCOCXYLON FMuell var PAUPERITA J.E.Brown

E. CAMALDULENSIS Dehn

E. MACRORRHYNCHA FMuell (for detail of western boundary see Boomsmma 1949)

E. ODORATA Behr & Schlecht.

E. ELAEOPHORA FMuell.

MALLEES (E. CALCICULTRIX FMuell.

E. LANSDOWNEANA FMuell. & J.E.Brown

E. OLEOSA FMuell.

E. OLEOSA FMuell. var. GLAUCA Maiden

E. ODORATA Behr & Schlecht.

MALLES FORM)

CLEARED LAND OR. NATURAL GRASSLAND

PRESUMABLY. NATURAL GRASSLAND (MARKED "NO TIMBER" OR "OPEN" IN EARLY SURVEYS)

+ CALLITRIS GLAUCA R.Br.

▲ CASUARINA STRICTA Ait.

Climate.

Meteorological data for almost all of the area mapped (excepting part of the Hd. Upper Wakefield) is given in the Commonwealth Bureau of Meteorology's Climatological Survey, Region 14—Goyder, South Australia (December 1956) from which some of the following data are extracted.

Temperature. The mean annual temperature is 55-60° F., with an amplitude of about 25° F. Maxima are fairly high in summer, minima in winter relatively low, frosts being common for several months. For the period 1906-39 the average frost free period at Clare was 195 days.

Rainfall. The wettest part of the district is near the highest point, Mt. Horrocks, 1982 ft., about 2½ miles east of Penwortham and Watervale. The highest local mean annual rainfall estimate was 29 in. for an area between these townships; it may be more on the mount itself. Rainfall tends to increase with increasing altitude locally, but falls away on passing northward. It decreases in all directions passing away from the Mt. Horrocks area—being 17-18 in. in the northern region and western boundary of the map, and almost 24 in. at the southern and south-eastern boundaries.

Evaporation. Calculations of evaporation from a free water surface (Commonwealth Bureau of Meteorology, 1963) show mean monthly evaporation varies between 10 in. and 11 in. in December and January, and between 1 in. and 2 in. in June and July at Clare, and is a little higher at Spalding, 6 miles to the north of this survey.

A map showing the mean length of the growing season, in months, is given in the Climatological Survey (ibid, Map No. 2). It has been compiled from a formula (Prescott and Thomas, 1949), as the period during which the rainfall exceeds $0.54 E^{0.75}$, where E is the evaporation from a free water surface expressed in inches. A growing season of seven months or more is shown in Hd. Clare, southern part of Hd. Milne, and the parts of the Hds. of Hart and Blyth adjoining them. It is also seven months in the surveyed part of Hd. Upper Wakefield. It drops below seven months north and west of these areas, and below six months in the north-eastern portion near Andrews.

The annual period when some water is stored in the soil at Clare has been estimated by the author by the method used by Prescott, Collins and Shierpurkar (1952) and found to be approximately 7.3 months (from the end of April to early to mid-December). It is assumed that the soil can only store 5 inches of rain, the rest being lost as drainage and runoff. Potential evapotranspiration, regarded as $0.8 E^{0.75}$, where E is the evaporation from a free water surface, is shown on Fig. 1. Evaporation estimates used were from the Bureau of Meteorology's Evaporation Maps of Australia (1963). Soil water storage, calculated from the balance of potential evapotranspiration and rainfall, is also given in Fig. 1 together with other climatological data for Clare, the only station in the area at which fairly full records are kept.

Soils.

The reconnaissance survey made in 1948-49 showed soils belonging to the following great soil groups, with a general distribution as follows:—

1. Podzolic soils. All examined are at the higher altitudes, above 1300 feet or within the area in which rainfall would be influenced by adjacent heights of 1300 feet. They occur mainly to the west, southwest and southeast of the township of Clare.

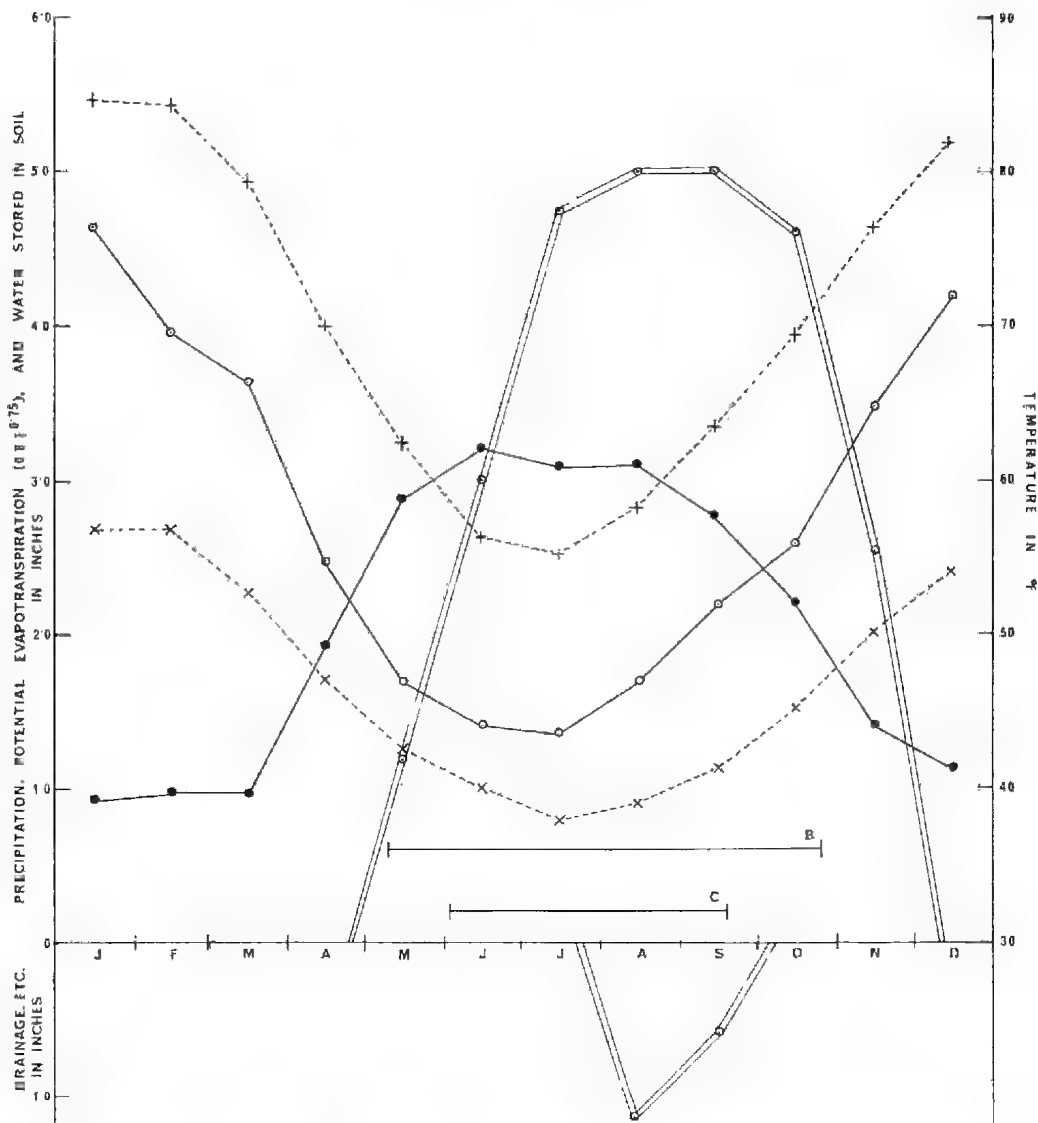


Fig. 1. Rainfall, potential evapotranspiration, water stored in soil, drainage, and temperature data for Clare, South Australia.

- Average monthly rainfall in inches (100 years of record to end of 1962).
 - $0.8E^{0.75}$, where E is the average monthly evaporation from a free water surface expressed in inches.
 - +—+—+ Average monthly maximum temperature in °F, (1879-1956).
 - x-x-x-x Average monthly minimum temperature in °F, (1879-1956).
 - Estimate of average total water stored in soil, also drainage, both expressed in inches.
- B Average dates first and last occurrences of screen minimum of 36° F: May 9 ± 11 days and October 25 ± 13 days.
- C Average dates first and last occurrences of screen minimum of 32° F: June 2 ± 10 days and September 18 ± 21 days.

(Data from Commonwealth of Australia Bureau of Meteorology)

2. Red-brown earths. Very extensive areas occur, particularly in the northern region through which the Hutt and Hill Rivers run, and to the west on the Blyth plains. Mulcahy (1954) describes those in the east of Hd. Upper Wakefield as shallow and deep (both common), with small areas of hydromorphic red-brown earths, and red-brown earths on travertine. Gilgais may occur locally.

3. Grey and brown soils of heavy texture with gilgai microrelief. Small areas were observed in Hds. Milne and Hart. They may be more extensive. Presumably these are allied to soils in the east of Hd. Upper Wakefield described by Mulcahy (ibid), as "grey and brown soils of heavy texture in which gilgais are present". In places they form complexes with red-brown earths.

4. Rendzinas, or degraded rendzinas. Two small areas were observed in Hd. Milne. They may be more extensive, and were common in the eastern part of Hd. Upper Wakefield surveyed by Mulcahy (ibid).

5. Terra rossa. Scattered areas, often very small, were reported by Mulcahy (ibid) in the eastern part of Hd. Upper Wakefield. This soil was not observed by the author.

6. Skeletal soils.

(a) Brown loams and clay loams over limestones are widespread in Hd. Upper Wakefield, in south-east Hd. Clare, and along the western slopes of the hills abutting the plains towards Blyth and Brinkworth.

(b) Skeletal soils over rocks other than limestone are found on the tops of ridges in all parts.

7. Alluvial soils are found along some water courses.

Ranges of Dominant Eucalypts and Allied Associations.

1. **Eucalyptus leucoxylon* F. Muell. var. *pauperita* J. E. Brown (Plates 1-4).

This is the most widely spread tree in the district. It occurs in hilly and undulating country from the southernmost part surveyed to well beyond North Bungaree, which is at the northern boundary of the survey. The mean annual rainfall varies between 17 in. and 29 in. This is well below the minimum of 25 in. for the species (*sensu stricto*) in the Mt. Lofty ranges (Specht and Perry 1948) and is close to the minimum of 19 in. or slightly less found for the species (*sensu stricto*) to the east in scattered occurrences from south of Burra to Keyneton (Jessup 1948). It is growing on podzolic soils, red-brown earths, brown loams over limestone, and skeletal soils over other rocks, including quartzite and siltstone.

The lower strata beneath this eucalypt vary in different parts of the district. Some indication of this is given by the lists of species associated with it in the regions in which the photographs (Plates 1-4) were taken. Extremes which are not shown in these photographs are dense sclerophyll scrub at Penwortham with a relatively high rainfall of 27 in., and *Triodia* grassland, on the hillslopes to the north of North Bungaree, with relatively low rainfall of 18 in.

There are also marked differences in the form of the tree. In the wetter soils to the west of Penwortham it is tall, straight and smooth-barked, very similar in form to *E. camaldulensis* in this area; in the drier parts it tends to be smaller and more spreading, with rough bark at the base or extending right up

* Nomenclature of eucalypts and other species follows Black (1943-57).

the main trunk or, rarely, even as far as the secondary branches. Isolated trees are always more spreading than those growing close together, but these differences cannot be entirely accounted for by the fact that the trees are often more isolated in the drier parts. Differences in other characters, such as width of leaf ($\frac{1}{2}$ -1 in.), size and shape of buds (operculum conical to rostrate), and shape of fruit are associated with the changes in the form of the tree. No fruits as large as those of *E. leucoxyton* (*sensu stricto*) were observed, though some were nearly as large.

There was never any doubt about assigning any of these individuals to *E. leucoxyton* var. *pauperita*. It is probable that this variation is caused by introgression of the species with *E. camaldulensis* in the wetter parts, and *E. odorata* in the drier parts. Hybrids of *E. leucoxyton* (*sensu stricto*) with both these species have been recorded in the Mt. Lofty Ranges by Specht and Perry (1948). It may well be that in some parts the environmental conditions are more suited to the development of a hybrid than to that of the species itself.

2. *E. camaldulensis* Dehnh. (Plate 5).

This species is found along some of the moister drainage lines in the wetter parts of Hds. Clare and Upper Wakefield, where the annual rainfall is less than 22 in. In one place, between Penwortham and Mt. Horrocks, it extends up from the gully onto the hillslopes naturally. This is the wettest known part of the district with a rainfall of about 29 in. However, it has been planted quite extensively in and around the area in which it occurs naturally, and is growing well in many places where the trees are not directly on a water-course, e.g. east of Watervale.

At three places in the Hd. Clare the author is indebted to Boomsma (1948) for records of the occurrence of this species i.e. (a) within the boundaries of the *E. macrorrhyncha* association, (b) in northwest Hd. Clare (sects. 1991, 1996), near a mallee patch, and (c) along the Hutt R. to the north of the township of Clare. In two places, on the Hutt R. flats and near Bärnia, in the southern part of Hd. Milne, *E. camaldulensis* which has been planted, is flourishing, and there are some similar healthy trees further north. The one soil profile taken was an alluvial soil. Proximity to water courses suggests that the species will be growing mainly in alluvial soils, but trees planted on various other soil types in the district are remarkably healthy. Close proximity to creeks confirms that germination is largely governed by high water requirement, as has been found for this species in other places.

3. *E. odorata* Behr and Schlecht. (Plate 9).

This species occurs along some of the boundaries of the *E. leucoxyton* var. *pauperita* association, either pure, or in association with it. It is mainly in the tree form, though there are some patches of the mallee form e.g. the one mapped in Hd. Blyth. Near North Bungaree a few isolated trees of the variety *angustifolia* are found.

E. odorata is found in hilly country with a mean annual rainfall of 18-24 in. It has been observed growing in red-brown earths, podzolic soils, and skeletal soils over limestone, and may also be growing on rendzinas and grey and brown soils of heavy texture with gilgai microrelief. These conditions of climate and soil are similar to those in which the species has previously been observed (Specht and Perry, *ibid*).

1. *E. macrorrhyncha* F. Muell. (Plate 7).

This species extends over an area of about five square miles to the west of Penwortham in a wet region with a rainfall of 24-29 in. It is the only known occurrence of the species in South Australia (Boomsma, 1948). Except for small areas at the northern end, where it occurs in association with *E. elaeophora*, it is a pure stand. Often the crowns of the trees form a fairly complete canopy. The boundaries between this association and those of *E. leucoxylon* var. *pauperita* and *E. camaldulensis*, which adjoin it, are very sharp, suggesting that its distribution is controlled by a soil factor. In most parts the soil is very stony and rocky, with many quartz fragments on the surface.

The ground flora is very varied where it has not been removed completely by grazing (Plate 7), but it is rather sparse, and consists largely of geophytes which flower in the spring. Bracken fern, *Pteridium aquilinum*, occurs in some of the gullies. Further information is given by Boomsma (1948).

5. *E. elaeophora* F. Muell. (Plate 6).

This species occurs in small areas in the hilly country in the western part of Hd. Clare, growing with *E. leucoxylon* var. *pauperita*, or *E. macrorrhyncha*. The association with the former is not always close; there are frequently small areas of one species or the other. No obvious reason for this separation was observed; the aspect of the slopes had no apparent influence on distribution.

All the soil profiles observed were podzolic. The mean annual rainfall is 24 to 27 in.

6. *Mallee* (Plate 5).

Isolated patches of mallee occur in Hds. Clare, Hart, and Yackamoorundie—in particular *E. oleosa*, *E. oleosa* var. *glauca* (= *E. transcontinentalis*), *E. calcicultrix*, *E. lansdowneana*, and the mallee form of *E. odorata* (mapped as *E. odorata* in Hd. Blyth).

Mean annual rainfall lies between 17 and 24 in. Surface soils were very sandy or stony, but no profiles were taken.

7. *Castuarina stricta* Ait. (Plates 1 and 2).

This species occurs in association with *E. leucoxylon* var. *pauperita* and *E. odorata*, and also by itself. It is found alone scattered on the tops of some of the ridges, particularly the stony ridges where the soils are mainly skeletal. It is also met with in places on red-brown earths, at the junctions between *E. leucoxylon* var. *pauperita* and the grassland associations. Present occurrences are at mean annual rainfalls between 17 and 26 in. It is impossible to estimate the original extent of the species, as it is easy to clear, much prized as firewood, and regeneration from seedlings is prevented by grazing animals. Apparently it did not occur originally on all the ridges. Those on the northern part of the eastern boundary of Hd. Milne, and extending into Hd. Andrews (outside the area mapped) are reputed to have originally been treeless, and so are the grassy hills at the extreme northwest of Hd. Clare, and the adjoining part of Hd. Blyth. The ground flora is not luxuriant, and consists mainly of grasses.

8. *Callistris propinqua* R.Br.

This species is found occasionally in the hills in the western part of Hd. Clare. It was formerly much more frequent, but has been removed for timber, and little regeneration appears to be taking place.

9. Tussock grassland (Plate 10).

Extensive areas of grassland occur to the north and east in Hds. Clare, Milne, and Andrews, and to the west in Hds. Blyth and Hart. They are now much altered by cultivation and grazing and often cannot be distinguished with certainty from cleared land. Originally the bulk of the natural grassland was probably dominated by species of *Stipa* and *Danthonia*. Tussocks of *Lomandra* and *Lepidosperma* spp. are often present (Plate 10).

The mean annual rainfall ranges from 16 to 26 in. The soils are mainly red-brown earths with some smaller areas of podzolic soils, brown loams over limestone, skeletal soils over other rocks, and grey and brown soils of heavy texture with gilgai microrelief.

Formations.

Notes taken in 1948-49 were not extensive enough to allow a full discussion of the formations (as defined by Wood and Williams, 1960).

Savannah woodland is extensive. This is mainly dominated by *E. leucoxylon* var. *pauperita* or *E. odorata*. Near Penwortham *E. leucoxylon* var. *pauperita* and its associated vegetation tend towards dry sclerophyll forest.

E. macrorrhyncha usually occurs, in other regions, as dry sclerophyll forest (Wood and Williams, 1960), and here, over much of the area dominated by this species, the crowns form a continuous canopy. In places (see Boomsma, 1948) *E. macrorrhyncha* is also growing as savannah woodland. Whether this is due to partial clearing, followed by growth of a grassy ground stratum, is not known.

Mallee and tussock grassland also occur. The latter is much modified by introduced species as pasture and otherwise, and in many places by cultivation.

DISCUSSION

Sufficient evidence to define the factors which control the distribution of the eucalypts in the part of County Stanley surveyed has not yet been collected. With minor exceptions it does not appear to be related to rainfall. Detailed soil survey may show close connections between eucalypt and soil type in some areas; in others the relationship between soil, moisture, and vegetation may be more complex.

Distribution of *E. camaldulensis* is presumably partly controlled by its need for a relatively high water supply, while that of *E. elaeophora*, *E. macrorrhyncha* and the mallees is probably controlled by soil factors. Tussock grassland, *E. leucoxylon* var. *pauperita* and *E. odorata* are found over almost identical rainfall ranges, and (with the exception of the probable absence of the two eucalypts from gilgai soils) in soils of the same great soil groups. More detailed study of the soils, and fuller information as to soil moisture relationships and nutrient status may give a fuller understanding of their distribution.

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EXPLANATION OF PLATES

Ground Flora in Photographs.

1. *Eucalyptus leucoxylon* var. *pauperita* on rocky outcrop. Note spreading habit. Hd. Milne, Sect. 3009.
Small tree: *Casuarina stricta*.
Ground stratum:
 **Homeria collina*, *Themeda australis*, **Aira caryophyllaea*, **Avena fatua*, *Danthonia* sp., *Dichopogon strictus*, *Ptilotus spathulatus*, **Trifolium arvense*, **T. procumbens*, **Erodium moschatum*, **Parentucellia latifolia* (= *Bartsia latifolia*), **Hypochaeris glabra*.
2. *E. leucoxylon* var. *pauperita* in undulating country without rocky outcrops. Note spreading habit. Hd. Milne, Sect. 3013.
Small tree: *Casuarina stricta*.
Ground stratum:
 **Homeria collina*, *Danthonia semianularis*, **Acellaria michelli*, **Briza maxima*, **Vulpia myuros*, **Vulpia bromoides*, *Dianella revoluta*, *Bulbine bulbosa*, *Dichopogon strictus*, *Ranunculus lappaceus*, *Stackhousia* sp., *Velleia paradoxa*, *Lagenophora* sp., *Microseris* sp.
3. *E. leucoxylon* var. *pauperita* in wetish situation—young trees. Hd. Milne, Sect. 3014.
Small trees and large shrubs: *Acacia armata*, *A. pycnantha*.
Ground stratum:
 **Homeria collina*, **Briza maxima*, **Briza minor*, **Bromus madritensis*, **Agropyron scabrum*, *Dichopogon strictus*, *Ranunculus lappaceus*, *Drosera* sp., *Acaena prina*, **Trifolium dubium*, **T. glomeratum*, **T. tomentosum*, *Swainsona* sp., **Stackhousia* sp., **Anagallis femina*, **Parentucellia latifolia* (= *Bartsia latifolia*), *Lagenophora* sp., *Craspedia uniflora*, *Microseris* sp., **Hypochaeris glabra*, **Sonchus* sp.
4. *E. leucoxylon* var. *pauperita* on podzolised soil west of Clare. Note relatively strong development of main trunk. Paddock at rear has been cleared. Hd. Clare, Sect. 7197.
Small trees and large shrubs: *Callitris propinqua*, *Casuarina stricta*, *Acacia pycnantha*.
Small shrubs: *Pultenaea* sp., **Lacandula stoechas*.
Ground stratum:
 **Briza minor*, *Thysanotus patersonii*, *Bulbine bulbosa*, *Dichopogon strictus*, **Anagallis femina*, *Lagenophora* sp.
5. *E. camaldulensis* growing along creek near Penwortham. Hd. Clare, Sect. 82.
6. *E. elaeophora*, west of Clare. Hd. Clare.
Small trees or large shrubs: *Casuarina stricta*, *Acacia pycnantha*.
Ground stratum:
 Dianella revoluta, *Hibbertia* sp., *Goodenia* sp., *Lagenophora* sp., Many grasses.
7. *E. magerorhyncha* in hilly country south-west of Clare. Hd. Clare, Sect. 2373.
Ground stratum has been almost completely removed by grazing.
8. Mallee—north-west of Hundred of Clare. Hd. Clare, Sect. 1955.
Mallees: *E. oleosa*, *E. oleosa* var. *glauca* (= *E. transcontinentalis*), *E. calcicultrix*.
Large shrubs: *Melaleuca pubescens*, *Bursaria spinosa*.
Ground stratum:
 Lomandra spp.
9. *E. odorata* in Hd. Hart, Sect. 150?
Ground stratum:
 **Homeria collina*, *Danthonia* sp., **Vulpia myuros*, **Medicago minima*, **Parentucellia latifolia* (= *Bartsia latifolia*), **Cryptostemma calendula*, **Hedypnois cretica*.
10. Tussock grassland association, Hd. Hart, from Main North Road, west of Anama, looking westwards towards Brinkworth. Tussocks are of *Lepidosperma* sp. and *Lomandra* sp.

* Introduced species.